



# The Scout short-arc orbit determination and impact hazard assessment system

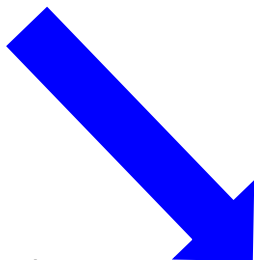


**Jet Propulsion Laboratory**  
California Institute of Technology

D. Farnocchia, S.R. Chesley,  
S.P. Naidu, A.B. Chamberlin



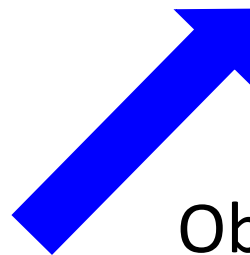
Observations  
reported



Confirmation  
process



Object added to  
the catalog



# Sentry: Earth Impact Monitoring

[Introduction](#)[Object Table](#)[VI Table](#)[FAQ](#)[Operational Notes](#)[Removed Objects](#)

## Impact Risk Data

The following table summarizes by object the potential future Earth impact events that the JPL [Sentry System](#) has detected based on currently available observations. Click on the object designation to go to a page with full details on that object.

[Sentry](#) is a highly automated collision monitoring system that continually scans the most current asteroid catalog for possibilities of future impact with Earth over the next 100 years. Whenever a potential impact is detected it will be analyzed and the results immediately published here, except in unusual cases where we seek independent confirmation. It is normal that, as additional observations become available, objects will disappear from this table whenever there are no longer any potential impact detections. For this reason we maintain a [list of removed objects](#) with the date of removal.

### Table Settings:

[\[ Use Unconstrained Settings \]](#) [\[ Use Defaults \]](#)

Observed anytime ▾

Any Impact probability ▾

Any Palermo scale ▾

Any H ▾

Show 10 ▾ entries

Showing 1 to 10 of 815 entries

Search: 

Object Designation	Year Range	Potential Impacts	Impact Probability (cumulative)	$V_{\infty}$ (km/s)	H (mag)	Estimated Diameter (km)	Palermo Scale (cum.)	Palermo Scale (max.)	Torino Scale (max.)
<a href="#">(2010 GZ60)</a>	2018-2116	475	5.4e-6	2.98	16.1	2.000	-0.90	-1.98	0
<a href="#">29075 (1950 DA)</a>	2880-2880	1	1.2e-4	14.10	17.6	1.300	-1.42	-1.42	
<a href="#">101955 Bennu (1999 RQ36)</a>	2175-2199	78	3.7e-4	5.99	20.2	0.490	-1.71	-2.32	
<a href="#">410777 (2009 FD)</a>	2185-2198	7	1.6e-3	15.87	22.1	0.160	-1.78	-1.83	
<a href="#">(2017 RH16)</a>	2026-2117	49	8.5e-4	12.78	25.6	0.026	-2.59	-2.59	0
<a href="#">(2010 AU118)</a>	2020-2112	38	1.8e-8	25.22	16.2	1.900	-2.72	-3.14	0
<a href="#">(1979 XB)</a>	2056-2113	2	7.4e-7	23.92	18.5	0.662	-2.82	-3.12	0
<a href="#">(2007 FT3)</a>	2019-2116	165	1.5e-6	17.06	20.0	0.340	-2.82	-3.17	0
<a href="#">99942 Apophis (2004 MN4)</a>	2060-2105	12	8.9e-6	5.85	19.1	0.370	-2.83	-2.93	0
<a href="#">(2000 SG344)</a>	2069-2113	101	2.6e-3	1.36	24.8	0.037	-2.86	-3.23	0

Print

CSV

Excel

Previous

1

2

3

4

5

...

82

Next

# Sentry: Earth Impact Monitoring

[Introduction](#)
[Object Table](#)
[VI Table](#)
[FAQ](#)
[Operational Notes](#)
[Removed Objects](#)

## Impact Risk Data

The following table summarizes by object the potential impact risk based on currently available observations. Click on the object designation to go to a page with more details.

Sentry is a highly automated computer program that monitors the sky for objects that could impact with Earth over the next 100 years. Whenever a potential impact is detected, the system automatically generates a report. We seek independent confirmation. It is normal that, as additional observations are collected, the impact risk for some objects changes. For this reason we maintain a [list of removed objects](#).

### Table Settings

 Observed and

 [ Use Defaults ]

 Show  entries

Showing 1 to 10 of 815 entries

 Search: 

Object Designation	Year Range	Number of Observations	Orbit Uncertainty (km)	Orbit Uncertainty (AU)	Orbit Uncertainty (Miles)	Orbit Uncertainty (Miles)	Palermo Scale (cum.)	Palermo Scale (max.)	Torino Scale (max.)	
<a href="#">(2010 GZ60)</a>	2018-2116	475					2.000	-0.90	-1.98	0
<a href="#">29075 (1950 DA)</a>	2880-2880	1	1.2e-4	14.10	17.6	1.300	-1.42	-1.42		
<a href="#">101955 Bennu (1999 RQ36)</a>	2175-2199	78	3.7e-4	5.99	20.2	0.490	-1.71	-2.32		
<a href="#">410777 (2009 FD)</a>	2185-2198	7	1.6e-3	15.87	22.1	0.160	-1.78	-1.83		
<a href="#">(2017 RH16)</a>	2026-2117	49	8.5e-4	12.78	25.6	0.026	-2.59	-2.59	0	
<a href="#">(2010 AU118)</a>	2020-2112	38	1.8e-8	25.22	16.2	1.900	-2.72	-3.14	0	
<a href="#">(1979 XB)</a>	2056-2113	2	7.4e-7	23.92	18.5	0.662	-2.82	-3.12	0	
<a href="#">(2007 FT3)</a>	2019-2116	165	1.5e-6	17.06	20.0	0.340	-2.82	-3.17	0	
<a href="#">99942 Apophis (2004 MN4)</a>	2060-2105	12	8.9e-6	5.85	19.1	0.370	-2.83	-2.93	0	
<a href="#">(2000 SG344)</a>	2069-2113	101	2.6e-3	1.36	24.8	0.037	-2.86	-3.23	0	




Previous






...



*Sentry: your trusted  
impact monitoring system  
since 2001*



# Time is of the essence

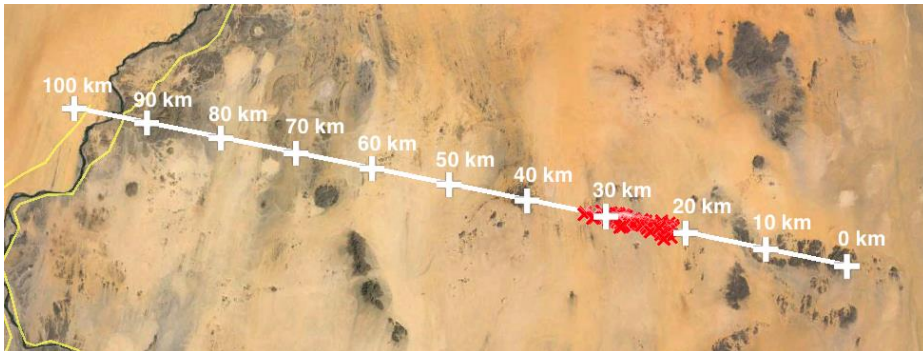


~ 5 m

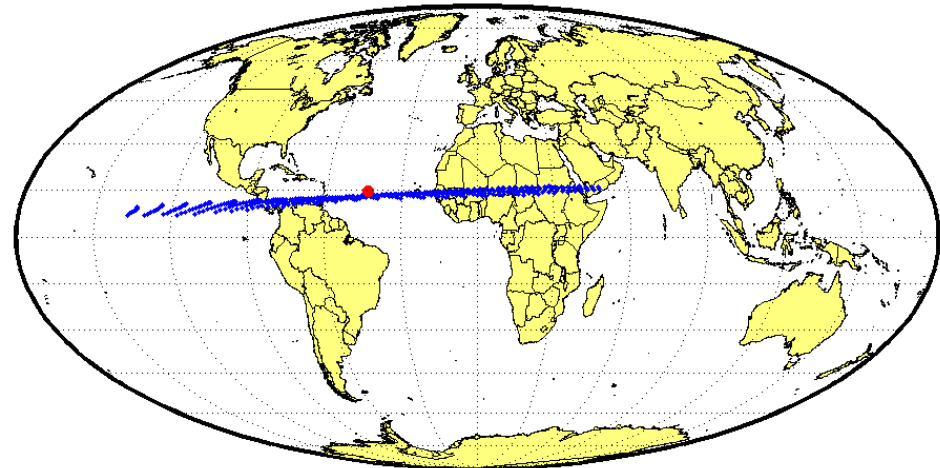
R. Kowalski, Catalina Sky Survey

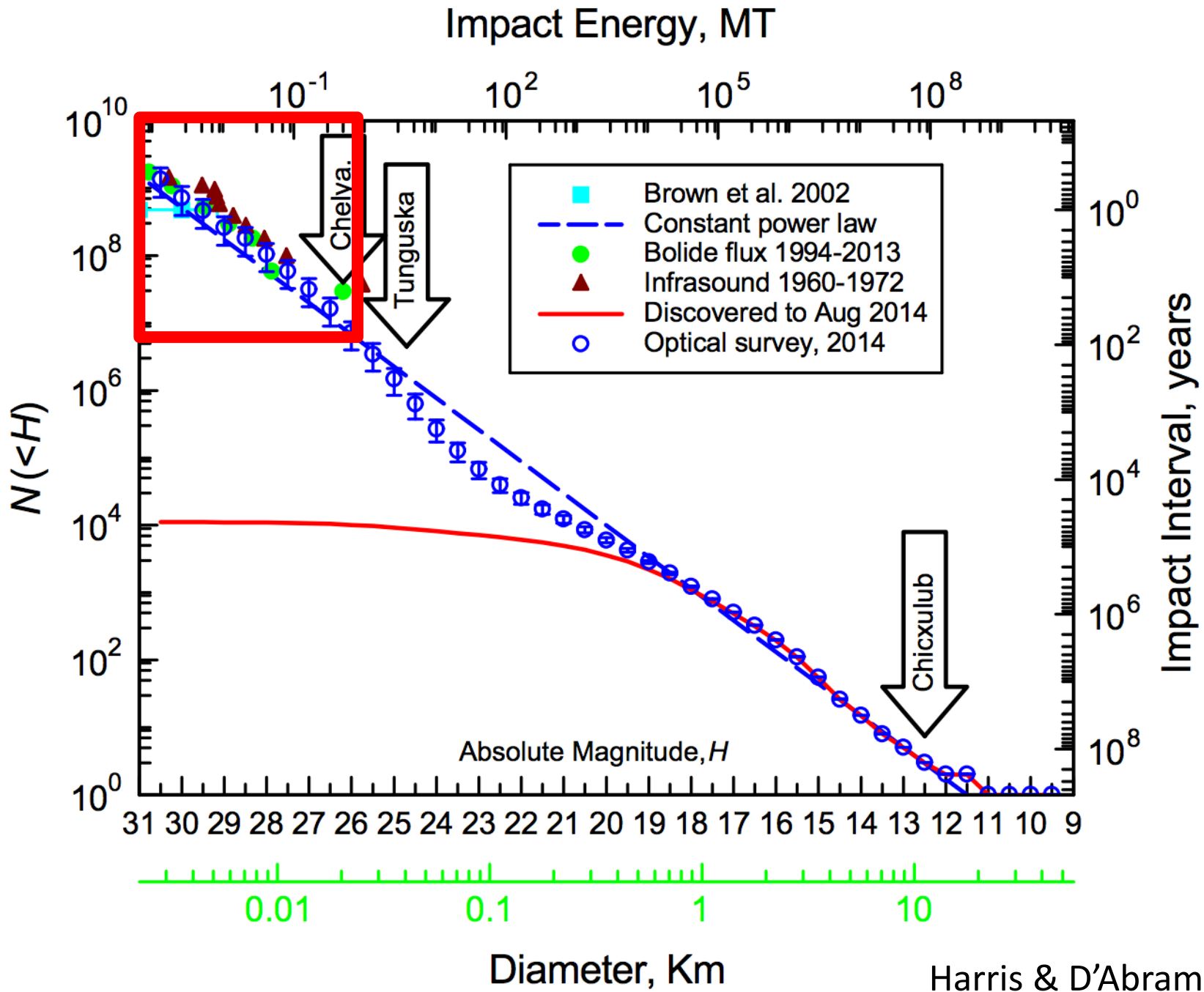
~ 20 hours before impact

2008 TC<sub>3</sub> Nubian desert, Sudan



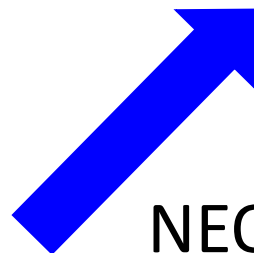
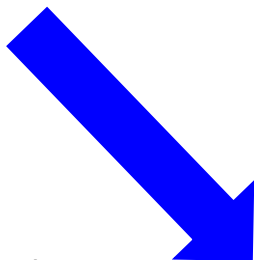
2014 AA Atlantic Ocean





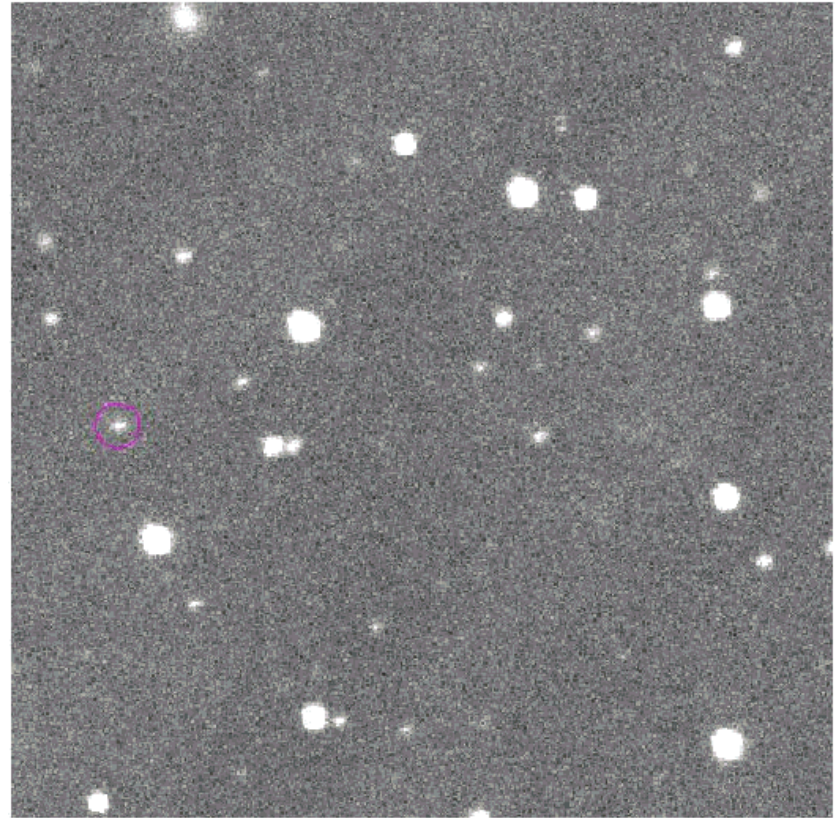
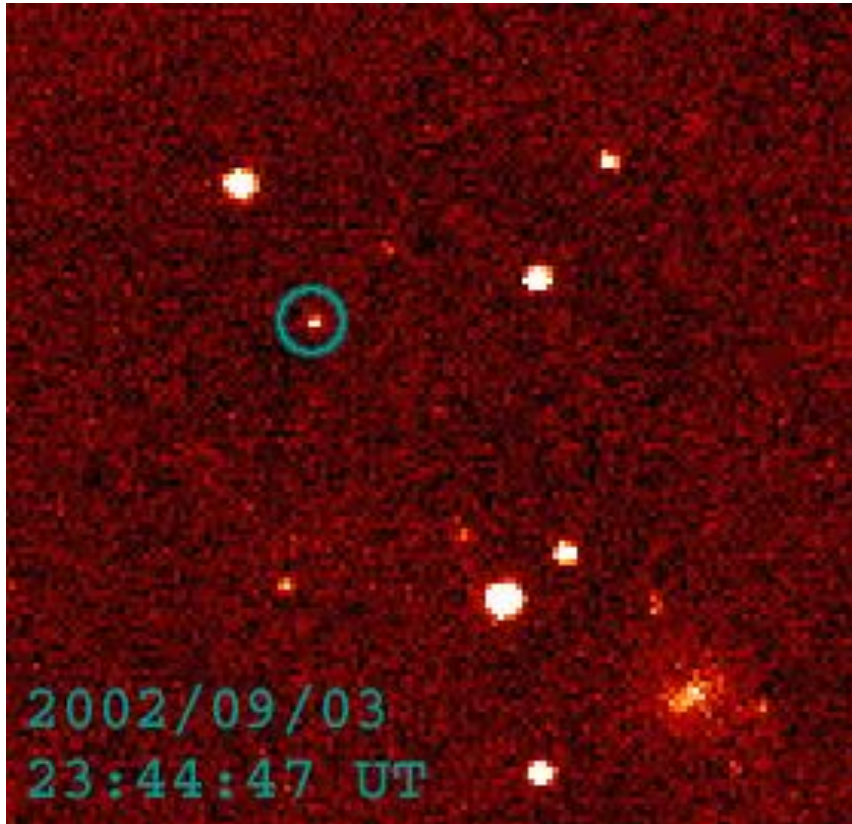


Observations  
reported



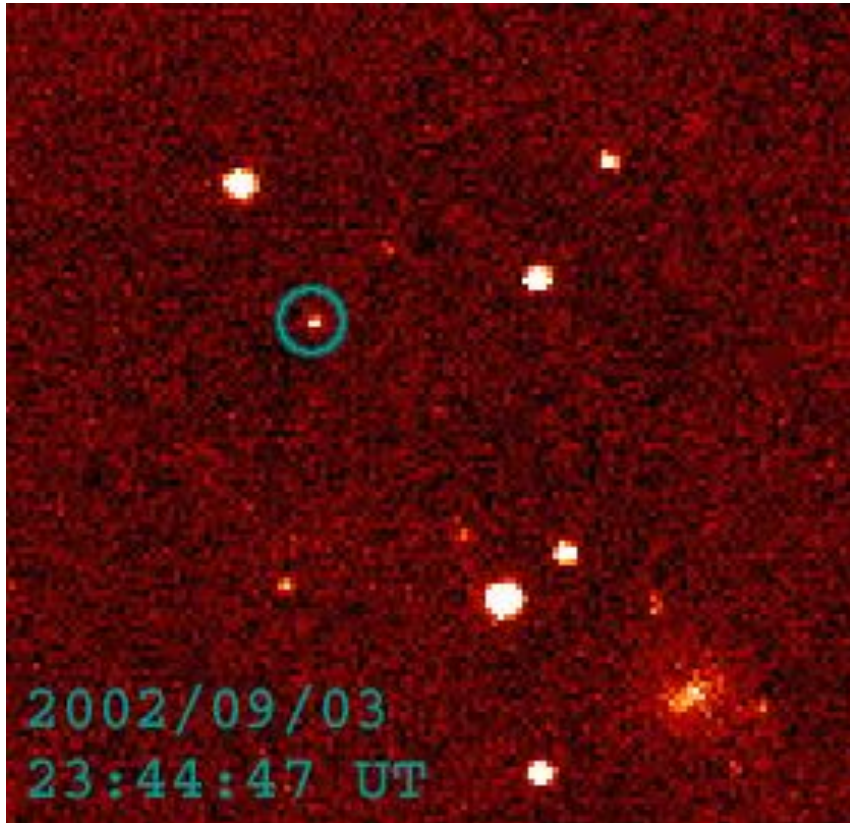
NEO Confirmation  
Page



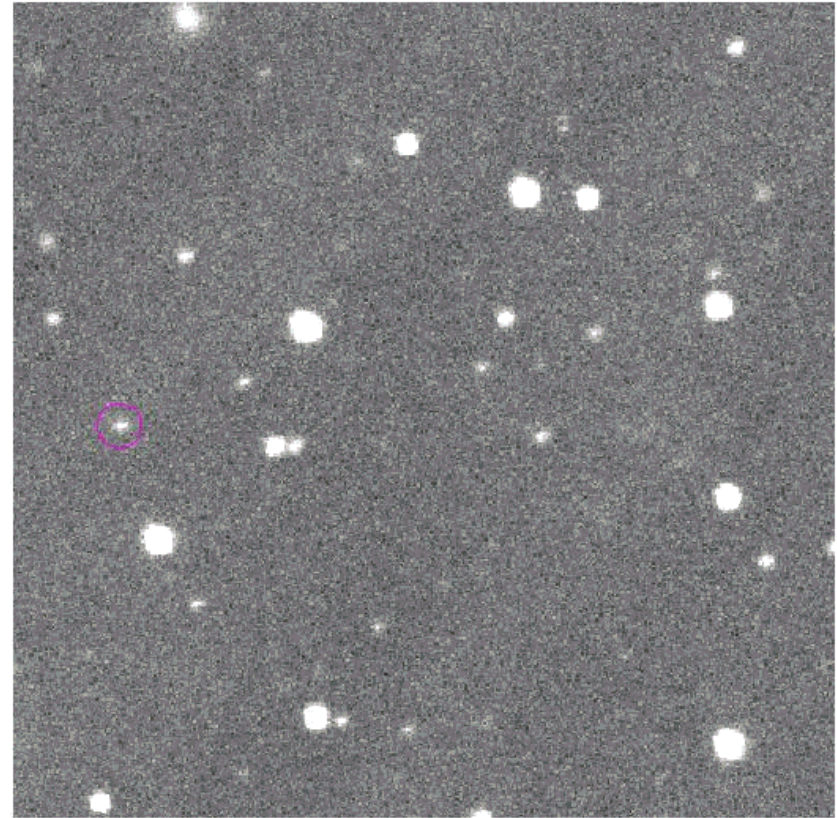




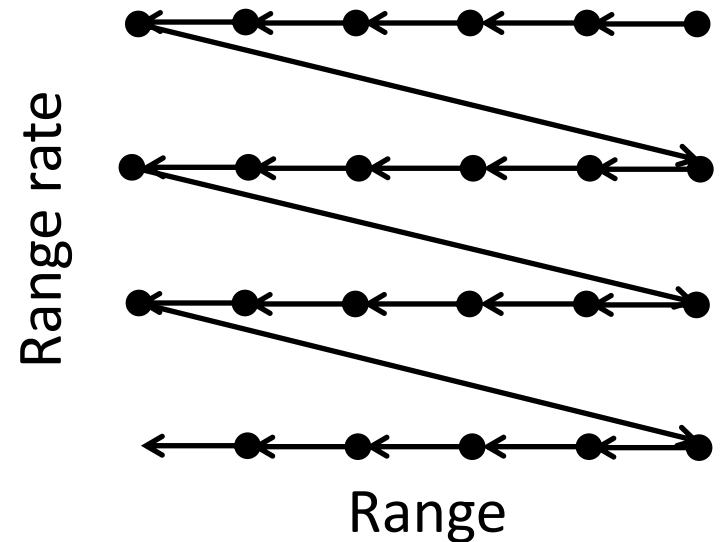
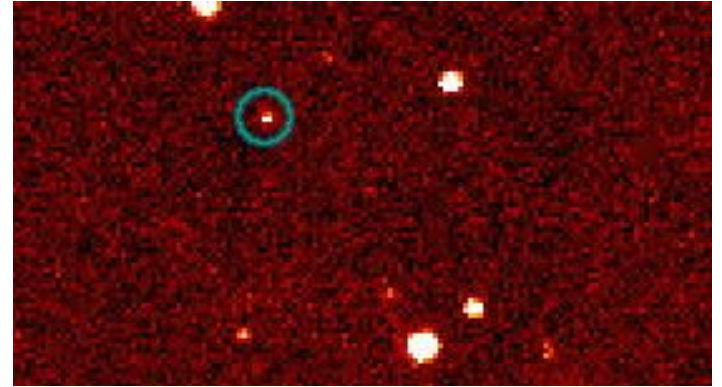
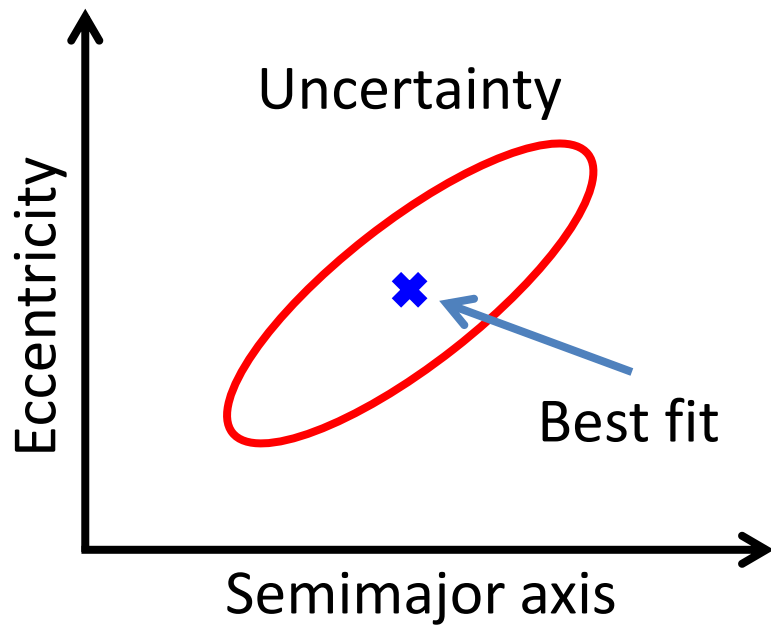
Routine NEO



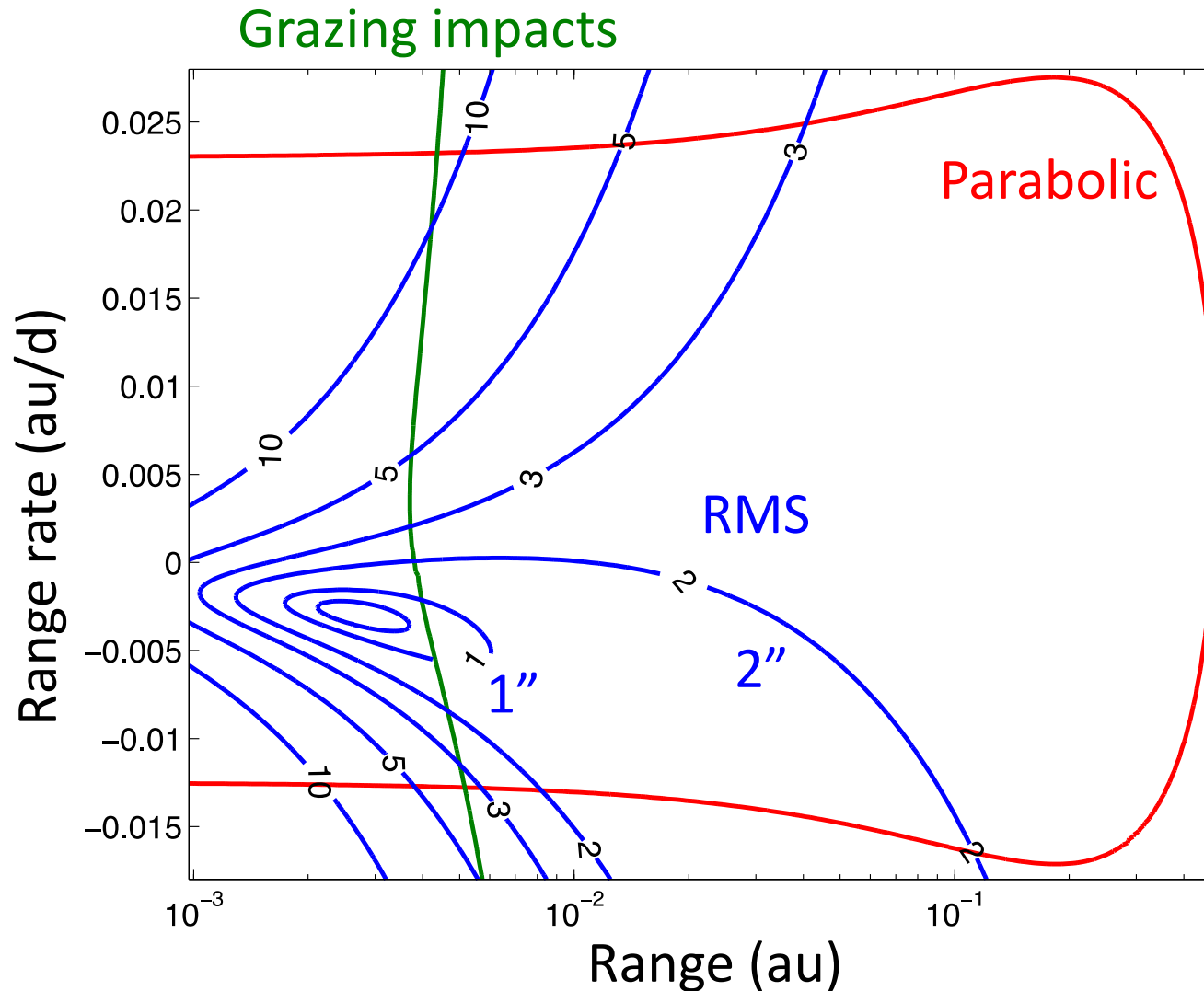
Impactor



# Systematic ranging



# Systematic ranging on 2014 AA



# Scout: NEOCP Hazard Assessment

- Introduction
- Data Table**
- Object Data
- Ephemeris

## Data Table

Scout data are about *unconfirmed objects* and all information should therefore be treated as *potentially unreliable*.

The following table contains [NEOCP](#) objects analyzed by [Scout](#). Because of the generally short observation arcs and the uncertain quality of the astrometry, the reported impact ratings and scores are meant to identify interesting objects rather than provide a rigorous probability assessment.

**Table Filter:** Enter desired filter parameter values then press the "Apply Filter" button.

NEO Score (min)	<input type="text"/>	V-mag (range)	<input type="text"/>	<input type="text"/>	RA (range)	<input type="text"/>	<input type="text"/>
POS Unc. (range)	<input type="text"/>	<input type="text"/>	Elong. (min)	<input type="text"/>	Dec (range)	<input type="text"/>	<input type="text"/>
POS Unc.+1 (range)	<input type="text"/>	<input type="text"/>	Rate (max)	<input type="text"/>	<input type="button" value="Apply Filter"/> <input type="button" value="Reset"/>		

Showing 1 to 69 of 69 entries

Search:

Object	#obs	Arc (h)	RMS	H	Impact Rating	MOID (au)	CA Dist. (LD)	V <sub>inf</sub> (km/s)	PHA	NEO	NEO > 1km	Geo.	IEO	T <sub>J</sub> < 3	Last Update (UTC)	RA (hh:mm)	Dec. (deg.)	Elong. (deg)
<a href="#">ZTF01Ym</a>	6	1.18	0.31	25.2	1	0.01	6.2	16.0	0	100	0	0	0	45	2018-09-28 18:12	02:12	-39	13
<a href="#">P20Jyx5</a>	3	0.59	0.14	26.3	1	0.006	11	10.9	0	100	0	0	0	36	2018-10-04 16:01	02:47	+13	14
<a href="#">P20Jril</a>	3	0.84	0.22	18.9	1	0.4			0	57	9	0	0	61	2018-10-02 18:06	00:40	+06	17
<a href="#">ZSA598F</a>	4	0.41	0.34	26.8	0	0.01	5.2	10.4	0	100	0	0	0	53	2018-09-30 09:19	03:49	+52	11
<a href="#">ZSA3500</a>	3	0.41	0.37	25.9	0	0.06	24		0	100	0	0	0	43	2018-09-30 07:58	23:12	+17	15
<a href="#">A108U34</a>	4	0.72	0.21	27.9	0	0.0005	0.29	9.6	0	100	0	1	0	51	2018-10-01 13:34	08:53	+13	6
<a href="#">A108Z7p</a>	4	0.72	0.28	27.4	0	0.007	2.7	11.1	0	100	0	0	0	49	2018-10-03 13:00	02:09	-39	13
<a href="#">ZSA1411</a>	8	1.65	0.78	27.6	0	0.009	3.4	16.1	0	100	0	0	0	60	2018-09-30 11:00	09:00	-43	6
<a href="#">ZSA4C92</a>	4	0.41	0.42	29.8	0	0.001	0.59	19.7	0	100	0	0	0	61	2018-09-30 08:49	11:47	-00	14
<a href="#">P20Jurc</a>	3	0.56	0.00	26.7	0	0.01	5.8	21.9	0	97	0	0	0	46	2018-10-03 21:26	00:19	-11	16
<a href="#">P20Jri9</a>	3	0.84	0.01	25.9	0	0.05	19	18.3	0	100	0	0	0	43	2018-10-02 17:07	01:46	-21	15
<a href="#">A108Z7t</a>	3	0.48	0.02	24.7	0	0.01	6.3	29.0	0	100	0	0	0	28	2018-10-03 15:32	00:28	-18	15
<a href="#">A108WON</a>	4	0.77	0.45	23.2	0	0.02	14	14.5	0	100	0	0	0	56	2018-10-02 15:47	02:56	22	13



# Non-linear plane-of-sky uncertainty

Select NEOCP Object ▾

## Ephemerides

Enter desired ephemeris parameters.

By default, a geocentric (code=500) ephemeris is generated at the current time with no limit

Start Time (UTC):

Current time

Observatory Code:

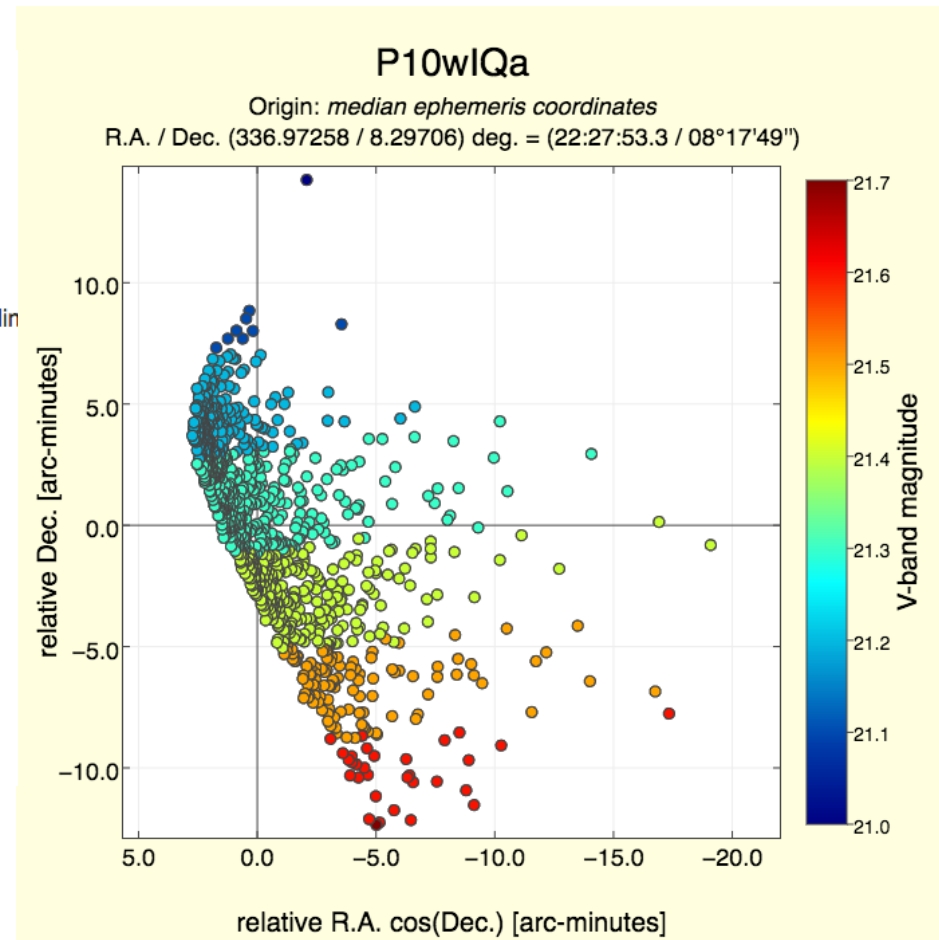
500

Stop Time (UTC):

Limiting magnitude:

Time Step:

Submit



1 of 2

FRM:JPL Scout System

SUBJ:Scout: ZLAF9B2

MSG:IP = 5%, CA\_DIST=6.1 RE,

URL = <http://>

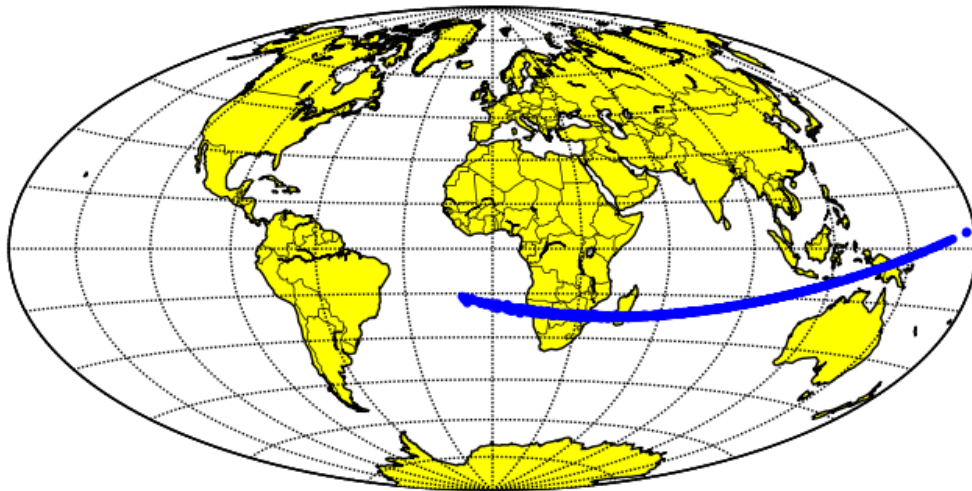
[cneos.jpl.nasa.gov/scout/#/](http://cneos.jpl.nasa.gov/scout/#/)

[object/ZLAF9B2](http://cneos.jpl.nasa.gov/scout/#/object/ZLAF9B2)

2018 June 2

11:32 UT

ZLAF9B2 = 2018 LA



Based on 11 observations  
from Catalina Sky Survey





MÖVENPICK So kann Eis sein.

MÖVENPICK So kann Eis sein.

MÖVENPICK So kann Eis sein.

MÖVENPICK So kann Eis sein.

MÖVENPICK  
SO KANN EIS SEIN



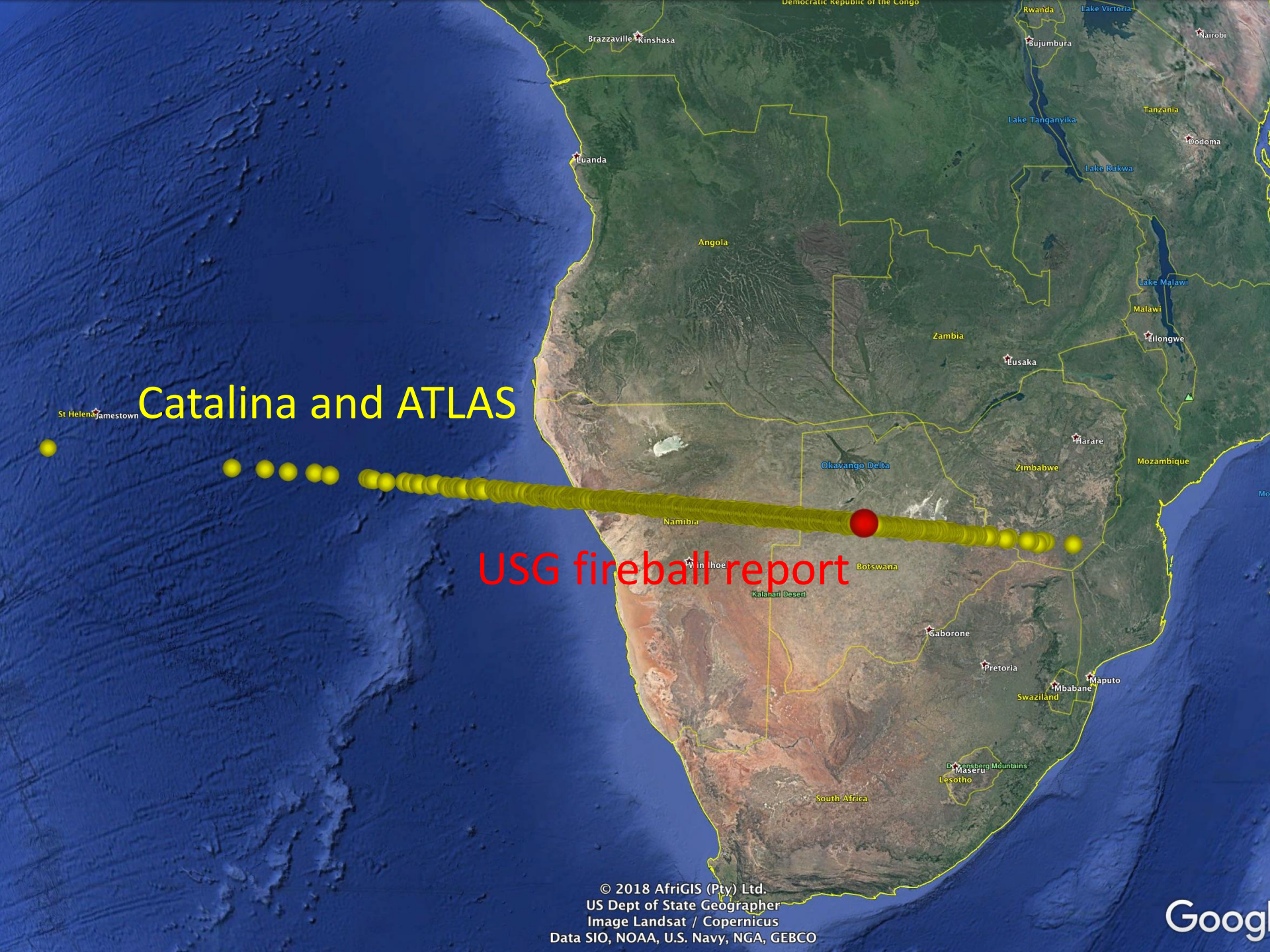




# Catalina and ATLAS

USG fireball report

St Helena Jamestown







<https://www.seti.org/press-release/fragment-impacting-asteroid-recovered-botswana-0>

# 2019 MO

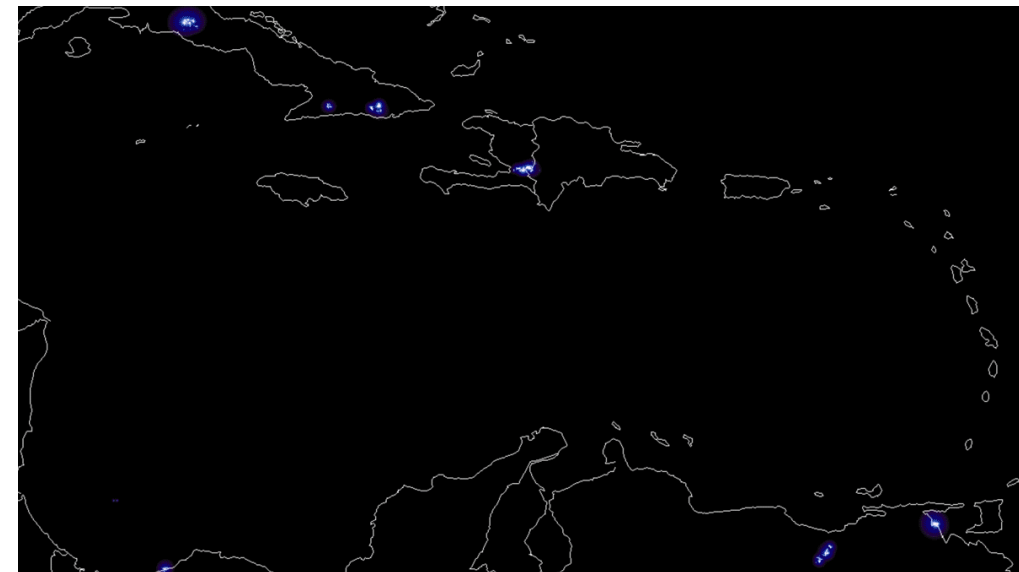
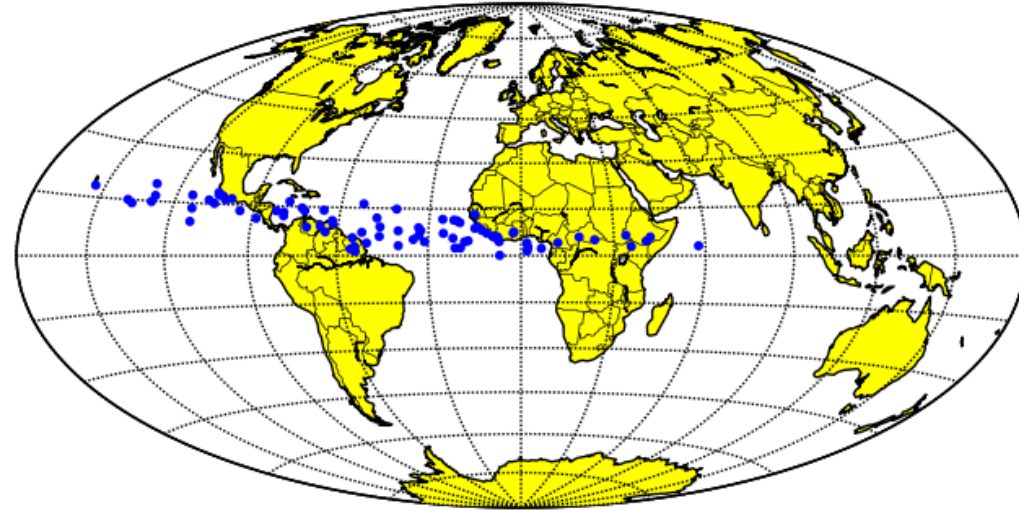
Impact on 2019 June 22

A few meters in size

Discovered by ATLAS 11 h  
prior to impact

No additional data,  
impact probability 0.4%

Pan-STARRS precoveries



Geostationary Lightning Mapper

# 2022 EB5

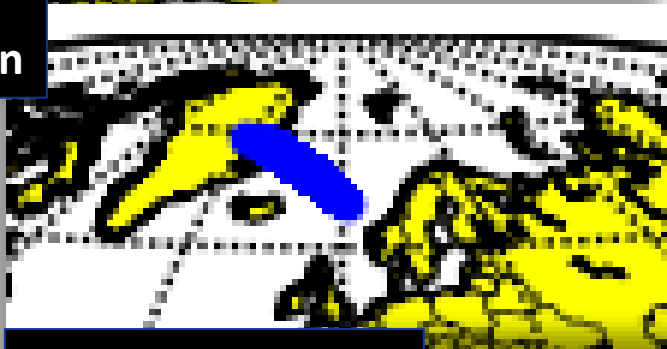
Impact on 2022 March 11

~2 m in size

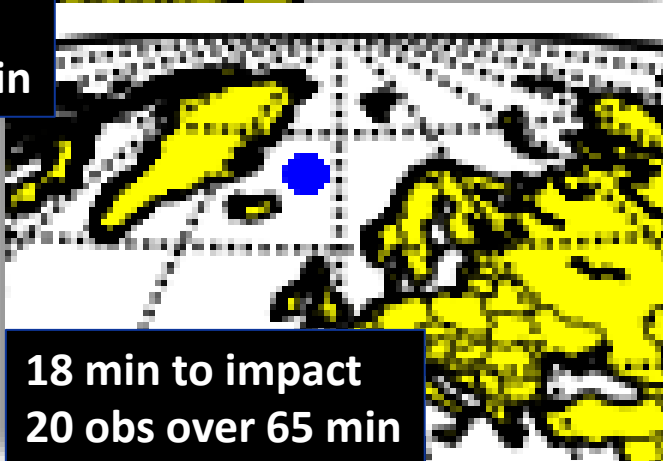
Discovered by Hungarian  
observatory GINOP-KHK  
2 h before impact



**56 min to impact  
14 obs over 33 min**



**46 min to impact  
20 obs over 40 min**

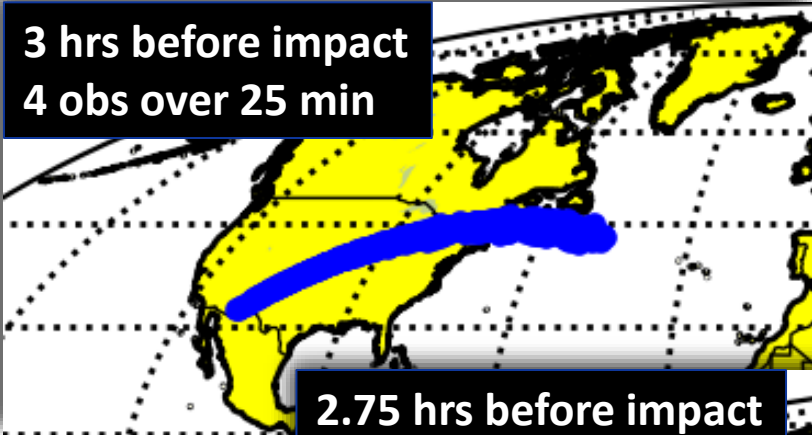


**18 min to impact  
20 obs over 65 min**

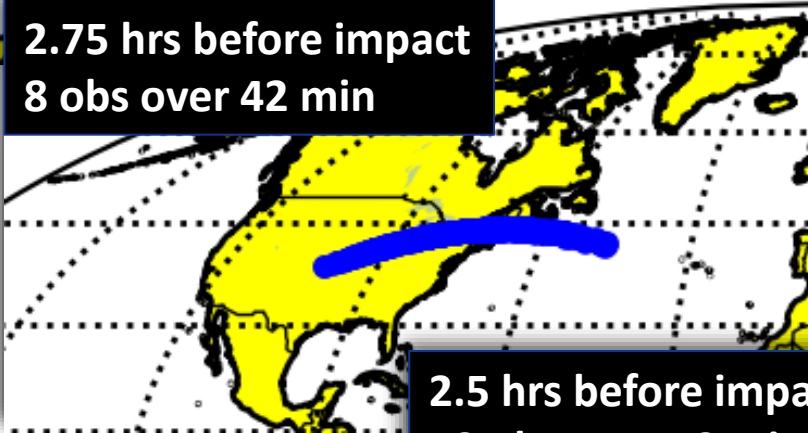


# 2022 WJ1

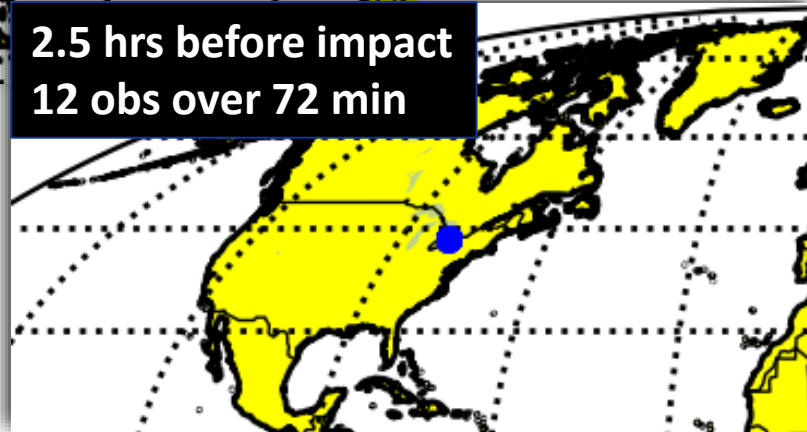
3 hrs before impact  
4 obs over 25 min



2.75 hrs before impact  
8 obs over 42 min



2.5 hrs before impact  
12 obs over 72 min



Impact on 2022 November 19

~ 1 m in size

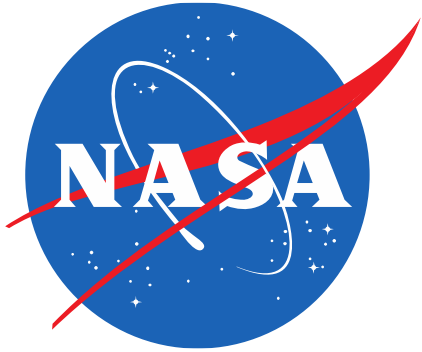
Discovered by Catalina  
3 h before impact



Credit: R. Weryk

# Summary

- Scout is a JPL system for early detection of asteroid impacts
- Still unconfirmed objects from the Minor Planet Center's NEO Confirmation Page
- Systematic ranging for orbit determination
- Rapid and fully automated, email & text alerts
- Real cases demonstrated capability of making accurate predictions and asteroid community responsiveness



# **Jet Propulsion Laboratory**

## **California Institute of Technology**

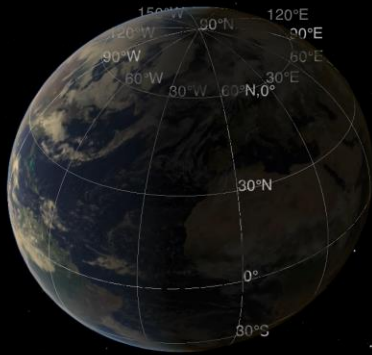
The research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration (80NM0018D0004).

© 2022. California Institute of Technology.  
Government sponsorship acknowledged.



# 2022 EB5

2022 Mar 11, 19:47:55 UTC  
1,000x time



# 2022 WJ1

2022 Nov 19, 07:04:31 UTC  
1,000x time



2022 WJ1

